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Estimating the duration of flow status along non perennial rivers by satellite data

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At present there is a great lack of hydrological information on non-perennial rivers. In many cases, there is no knowledge of which river reaches are subject to non-flow periods, and the duration of non-flow and dry periods remains unknown. Few hydrometric stations are present along non-perennial rivers, and these stations provide point information, limiting the ability to describe the flow conditions across a river reach. For example, they do not allow to distinguish a continuous line of flow from an isolated pools condition. In contrast, approaches based on field surveys or citizen science can provide information on flow condition over entire river reaches but their temporal resolution is generally poor. Within this framework, satellite remote sensing provides significant opportunities due to the possibility of monitoring large areas with high temporal resolution. However, the use of satellite images for monitoring non-perennial river regimes has so far been limited by the availability of images with adequate spatial resolution and their accessibility in terms of cost. Multispectral satellite data freely distributed by the European Space Agency's Copernicus Sentinel-2 mission, with a spatial resolution of 10 m and an acquisition frequency of approximately five days, represent an appropriate trade-off point for monitoring non-perennial rivers with active channels not covered by vegetation and larger than about 40 m.

In this study, we investigated the capability of Sentinel-2 data to differentiate among three flowing states of non-perennial rivers: "flowing" (F), "ponding" (P), and "dry" (D). The analysis was performed for 5 reaches of the streams Sciarapotamo, Mingardo and Lambro (Campania region, Italy). By analyzing the spectral signatures of land cover within river corridor, we identified the bands in which land cover classes are most differentiated. Utilizing these specific bands, we created a false-color image in which the pixels covered by water stand out from the background. The comparison between false color images and field acquired ground truth showed very good agreement. For all the archive data (since 2015) we identified one of the three possible flowing status: F, P and D. The acquired dataset was utilized to train a Random Forest model capable of predicting the daily occurrence of specific flowing statuses (F, P, D), using spatially interpolated

rainfall and air temperature data as predictors. The model demonstrated strong performance in terms of accuracy (ranging from 82% to 97%) and true skill statistic (ranging from 0.65 to 0.95). In each of the five years of the observation period, all the reaches underwent no-flow condition for at least a few days and in some cases up to four months. Three of the five reaches were completely dry each year while the other two never dried completely. With its ability to monitor the presence of water in a cost-effective manner, this method has the potential to significantly improve the knowledge on non-perennial rivers regimes.